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Universal quantum interfaces

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[]10 Mar 2003

abstract

To observe or control a quantum system, one must interact with it via an interface. This letter exhibits simple universal quantum interfaces—quantum input/output ports consisting of a single two-state system or quantum bit that interacts with the system to be observed or controlled. It is shown that under very general conditions the ability to observe and control the quantum bit on its own implies the ability to observe and control the system itself. The interface can also be used as a quantum communication channel, and multiple quantum systems can be connected by interfaces to become an efficient universal quantum computer. Experimental realizations are proposed, and implications for controllability, observability, and quantum information processing are explored.